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(71) Applicant: XEROX CORPORATION
Xerox Square
Rochester
New York 14644 (US)

(72) Inventor: Henry, Arnold W.
43 Deer Creek Rd
Pittsford, NY 14534 (US)
Inventor: Seanor, Donald A.
264 Garnsey Rd
Pittsford, NY 14534 (US)
Inventor: Kaplan, Samuel
1974 Finley Rd,
Webster
NY 14568-9787 (US)
Inventor: Pan, David H.
10 Westfield Commons,
Rochester
NY 14625 (US)
Inventor: Heeks, George J.
72 Oakcrest Dr,
Rochester
NY 14617 (US)
Inventor: Eddy, Clifford O.
248 Shorewood Dr,
Webster
NY 14581-1321 (US)
Inventor: Chow, Che C.
286 Valley Green Dr,
Penfield
NY 14526 (US)
Inventor: Badesha, Santokh S.
48 Bromley Rd,
Pittsford
NY 14534 (US)
Inventor: Kromm, Alvin D. Jr.
1126 Brook Tree Lane,
Webster,
NY 14580 (US)

(74) Representative: Johnson, Reginald George et al
Rank Xerox Ltd
Patent Department
Parkway
Marlow
Buckinghamshire SL7 1YL (GB)

(54) Fusing system and fluid release agent.

(57) A fusing system, method of fusing with a fuser member (1) having a thermally stable FKM hydrofluoroelastomer surface (2) for fusing thermoplastic resin toners to a substrate (12) in an electrostatographic printing apparatus has a polyorgano T-type amino functional oil release agent, the oil having predominantly monoamino functionality per active molecule to interact with the hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to the toner and a low surface energy film to release the toner from the surface.

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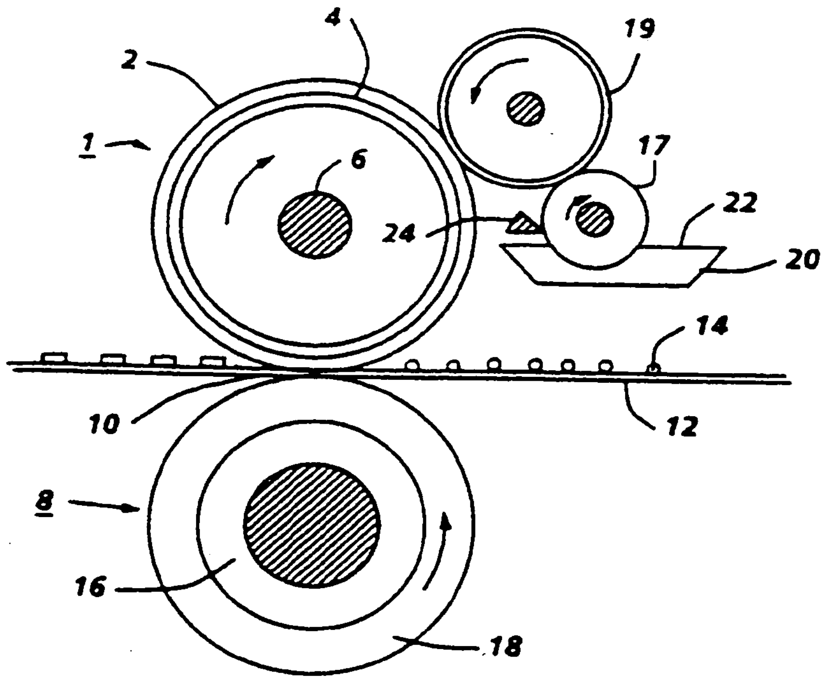

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The present invention relates to a fusing system, method of fusing as well as a release agent for the fusing system in an electrostatographic printing apparatus. In a particular embodiment it relates to the use of a novel, predominantly T-type monoamino functional silicone oil as a release agent in such a fusing system where the fuser member is a thermally stable hydrofluoroelastomer.

In a typical electrostatographic reproducing apparatus, a light image of an original to be copied is recorded in the form of an electrostatic latent image upon a photosensitive member and the latent image is subsequently rendered visible by the application of electroscopic thermoplastic resin particles which are commonly referred to as toner. The visible toner image is then in a loose powdered form and can be easily disturbed or destroyed. The toner image is usually fixed or fused upon a support which may be photosensitive member itself or other support sheet such as plain paper.

The use of thermal energy for fixing toner images onto a support member is well known. In order to fuse electroscopic toner material onto a support surface permanently by heat, it is necessary to elevate the temperature of the toner material to a point at which the constituents of the toner material coalesce and become tacky. This heating causes the toner to flow to some extent into the fibers or pores of the support member. Thereafter, as the toner material cools, solidification of the toner material causes the toner material to be firmly bonded to the support.

Typically, thermoplastic resin particles are fused to the substrate by heating to a temperature of between about 90° C to about 160° C or higher depending upon the softening range of the particular resin used in the toner. It is not desirable, however, to raise the temperature of the substrate substantially higher than about 200° C because of the tendency of the substrate to discolor at such elevated temperatures particularly when the substrate is paper.

Several approaches to thermal fusing of electroscopic toner images have been described in the prior art. These methods include providing the application of heat and pressure substantially concurrently by various means: a roll pair maintained in pressure contact; a belt member in pressure contact with a roll; and the like. Heat may be applied by heating one or both of the rolls, plate members or belt members. The fusing of the toner particles takes place when the proper combination of heat, pressure and contact time are provided. The balancing of these parameters to bring about the fusing of the toner particles is well known in the art, and they can be adjusted to suit particular machines or process conditions.

During operation of a fusing system in which heat is applied to cause thermal fusing of the toner particles onto a support, both the toner image and the support are passed through a nip formed between the roll pair, or plate or belt members. The concurrent transfer of heat and the application of pressure in the nip effects the fusing of the toner image onto the support. It is important in the fusing process that no offset of the toner particles from the support to the fuser member takes place during normal operations. Toner particles offset onto the fuser member may subsequently transfer to other parts of the machine or onto the support in subsequent copying cycles, thus, increasing the background or interfering with the material being copied there. The so called "hot offset" occurs when the temperature of the toner is raised to a point where the toner particles liquefy and a splitting of the molten toner takes place during the fusing operation with a portion remaining on the fuser member. The hot offset temperature or degradation of the hot offset temperature is a measure of the release property of the fuser roll, and accordingly it is desired to provide a fusing surface which has a low surface energy to provide the necessary release. To insure and maintain good release properties of the fuser roll, it has become customary to apply release agents to the fuser members to insure that the toner is completely released from the fuser roll during the fusing operation. Typically, these materials are applied as thin films of, for example, silicone oils to prevent toner offset.

Some recent developments in fuser members, release agents and fusing systems are described in US-A-4,264,181 to Lentz et al., US-A-4,257,699 to Lentz and US-A-4,272,179 to Seanor, all commonly assigned to the assignee of the present application. These patents describe fuser members and methods of fusing thermoplastic resin toner images to a substrate wherein a polymeric release agent having functional groups is applied to the surface of the fuser member. The fuser member comprises a base member having an elastomeric surface with a metal containing filler therein which has been cured with a nucleophilic addition curing agent. Exemplary of such fuser member is an aluminum base member with a poly(vinylidenefluoride-hexafluoropropylene) copolymer cured with bisphenol curing agent having lead oxide filler dispersed therein and utilizing a mercapto functional polyorganosiloxane oil as a release agent. In those fusing processes, the polymeric release agents have functional groups (also designated as chemically reactive functional groups) which interact with the metal containing filler dispersed in the elastomer or resinous material of the fuser member surface to form a thermally stable film which releases thermoplastic resin toner and which prevents the thermoplastic resin toner from contacting the elastomer material itself. The metal oxide, metal salt, metal alloy or other suitable metal compound filler dispersed in the elastomer or resin upon the fuser member surface interacts with the functional groups of the polymeric release agent. Preferably, the metal

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containing filler materials do not cause degradation of or have any adverse effect upon the polymeric release agent having functional groups. Because of this reaction between the elastomer having a metal containing filler and the polymeric release agent having functional groups, excellent release and the production of high quality copies are obtained even at high rates of speed of electrostatographic reproducing machines.

While the mechanism involved is not completely understood it has been observed that when certain polymeric fluids having functional groups are applied to the surface of a fusing member having an elastomer surface with a metal oxide, metal salt, metal, metal alloy or other suitable metal compounds dispersed therein there is an interaction (a chemical reaction, coordination complex, hydrogen bonding or other mechanism) between the metal of the filler in the elastomer and the polymeric fluid having functional groups so that the polymeric release agent having functional groups in the form of a liquid or fluid provides an excellent surface for release, having an excellent propensity to remain upon the surface of the fuser member. Regardless of the mechanism, there appears to be the formation of a film upon the elastomer surface which differs from the composition of the elastomer and the composition of the polymeric release agent having functional groups. This film, however, has a greater affinity of the elastomer containing a metal compound than the toner and thereby provides an excellent release coating upon the elastomer surface. The release coating has a cohesive force which is less than the adhesive forces between heated toner and the substrate to which it is applied and the cohesive forces of the toner.

The use of polymeric release agents having functional groups which interact with a fuser member to form a thermally stable, renewable self-cleaning layer having superior release properties for electroscopic thermoplastic resin toners is described in US-A-4,029,827 to Imperial et al., 4,101,686 to Strella et al. and 4,185,140 also to Strella et al., all commonly assigned to the assignee of the present invention. In particular, US-A-4,029,827 is directed to the use of polyorganosiloxanes having mercapto functionality as release agents. US-A-4,101,686 and 4,185,140 are directed to polymeric release agents having functional groups such as carboxy, hydroxy, epoxy, amino, isocyanate, thioether, and mercapto groups as release fluids. Some of these fusing systems have enjoyed significant commercial application. For example, a fuser roll made from Viton E 45 (a copolymer of 77 weight percent vinylidenefluoride and 23 weight percent hexafluoropropylene) filled with lead oxide has been successfully used in a fusing system employing a mercapto functional polyorganosiloxane release agent.

US-A-5,157,445 to Shoji et al. discloses a fixing device for an electrophotographic printer which uses a toner release agent containing as an active ingredient a functional group containing organopolysiloxane. The functional group may be - NH_2. The general formula 1 of this patent does not require any - NH_2 groups per molecule and the general formula 2 permits up to 10 - NH_2 groups per molecule.

According to the present invention, a fusing system, method of fusing and a novel release agent are provided for an electrostatographic printing machine. In particular, the novel release agent comprises a predominantly monoamino T-type functional polyorganosiloxane release agent. While the mechanism is not fully understood, it is believed that the amino functional oil can react with any toner capable of reacting with the amino groups. Multifunctional amino silicone oil molecules can react simultaneously with both the toner and the fuser roll surface thereby adhering the toner to the fuser roll surface to form the basis for further toner offsetting, shortening the functional life of the fuser roll. A monofunctional amino oil molecule can react either with the toner or the fluoroelastomer roll surface but not both. Hence, it can not act as a toner/fuser roll adhesive.

In a principle embodiment of the present invention, the substantially monoamino T-type functional oil has the formula:

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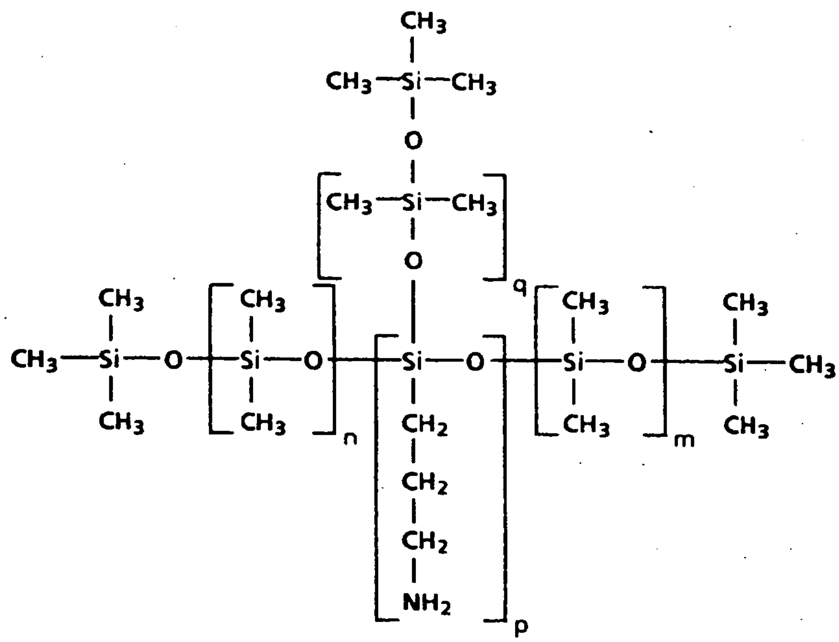

where $50 \leq n \leq 200$, p is 1 to 5, $50 \leq m \leq 200$ and q is 1 to 200 wherein at least 85% and and preferably about 93% of the polyorgano aminosiloxane functional chains have p equal to 1, said oil having predominantly monoamino functionality per active molecule to interact with said hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to said toner and a low surface energy film to release said toner from said surface.

In a further embodiment of the present invention the amino functionality is provided by aminopropyl/methyl siloxy groups.

In a further embodiment of the present invention the amino functional release agent remains functionally fluid at temperatures of from about 30° F to about 450° F.

In a further embodiment of the present invention while the degree of monofunctionality is desired to be high, the monoamino functional oil may be prepared in a batch process and may subsequently be diluted with nonfunctional oil as needed.

In a further embodiment of the present invention the fuser member is a thermally stable FKM hydrofluoroelastomer.

In a further embodiment of the present invention the monoamino functional release agent has a viscosity of from about 100 to about 1000 centipoise at 20°C.

The present invention will be described further by way of example with reference to the accompanying figure which is a sectional view of a fuser system which may use the fuser member according to the present invention.

A typical fuser member of the present invention is described in conjunction with a fuser assembly as shown in FIG. 1 where the numeral 1 designates a fuser roll comprising elastomer surface 2 upon suitable base member 4 which is a hollow cylinder or core fabricated from any suitable metal such as aluminum, anodized aluminum, steel, nickel, copper, and the like, having a suitable heating element 6 disposed in the hollow portion thereof which is coextensive with the cylinder. Backup or pressure roll 8 cooperates with fuser roll 1 to form a nip or contact arc 10 through which a copy paper or other substrate 12 passes such that toner images 14 thereon contact elastomer surface 2 of fuser roll 1. As shown in FIG. 1, the backup roll 8 has a rigid steel core 16 with a polymeric surface layer 18 thereon. Sump 20 contains a polymeric release agent 22 which may be a solid or liquid at room temperature, but is a fluid at operating temperatures.

In the embodiment shown in FIG. 1 for applying the polymeric release agent 22 to elastomer surface 2, two release agent delivery rolls 17 and 19 rotatably mounted in the direction indicated are provided to transport release agent 22 from the sump 20 to the elastomer surface. As illustrated in FIG. 1, roll 17 is partly immersed in the sump 20 and transports on its surface release agent from the sump to the delivery roll 19. By using a metering blade 24 a layer of polymeric release fluid can be applied initially to delivery roll 19 and subsequently to elastomer 2 in controlled thickness ranging from submicrometer thickness to

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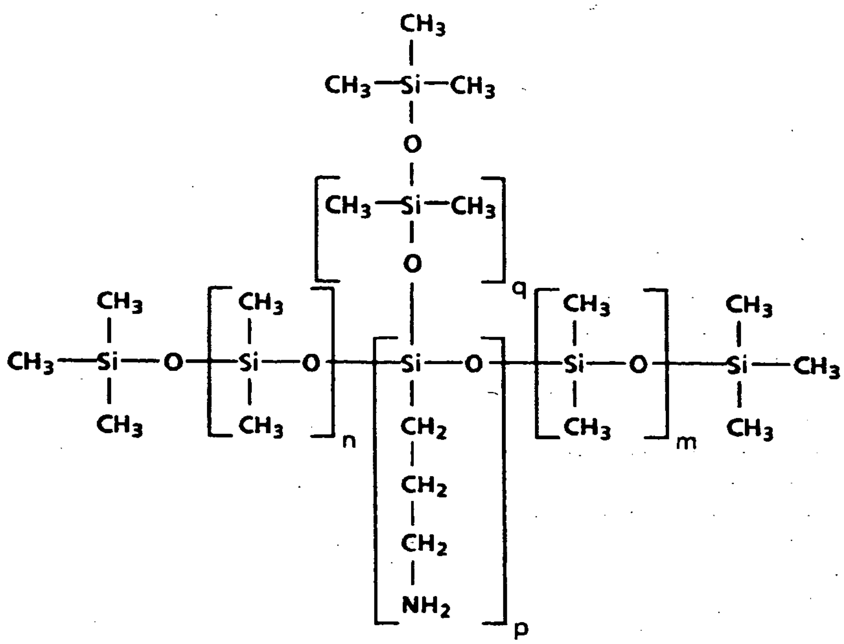
thickness of several micrometers of release fluid. Thus, by metering device 24 about 0.1 to 2 micrometers or greater thickness of release fluid can be applied to the surface of elastomer 2.

As used herein, the term fuser member may be a roll, belt, flat surface or other suitable shape used in the fixing of thermoplastic toner images to a suitable substrate. It may take the form of a fuser member, a pressure member or a release agent donor member preferably in the form of a cylindrical roll. Typically, the fuser member is made of a hollow cylindrical metal core, such as copper, aluminum, steel and like, and has an outer layer of the selected cured fluoroelastomer. Alternatively, there may be one or more intermediate layers between the substrate and the outer layer of the cured elastomer if desired. Typical materials having the appropriate thermal and mechanical properties for such layers include silicone elastomers, fluoroelastomers, EPDM and Teflon PFA sleeved rollers.

The predominantly monoamino T-type functional oil release agents according to the present invention can be represented by the formula:



where 50 ≦ n ≦ 200, p is 1 to 5, 50 ≦ m ≦ 200 and q is 1 to 200 wherein at least 85% and preferably about 93% of the polyorgano amino functional siloxane chains have p equal to 1 and the said oil having predominantly monoamino active molecules to interact with said hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to said toner and a low surface energy film to release said toner from said surface.

If the amino group reacts only with the toner, an interfacial barrier layer is also formed which is at least in part carried off with the copy sheet. The amino functional oil may react with the hydrofluoroelastomer or the toner by similar reactions, the primary reaction being an addition reaction across a double bond. In the ideal case in the above formula p would equal 1 but as a practical matter it is difficult to limit all chains to a p of 1 and therefore the small range of p is 1 to 5 is specified. By the term predominantly monoamino functional oil we mean that greater than 85% and preferably about 93% of the functional oil molecules have one and only one amino group on the silicone oil molecule hence, less than 15% of the active silicone oil molecules have more than one amino group covalently bonded to them. This is in sharp contrast to the organopolysiloxane of formula II in the above-referenced US-A-5,157,445 which permits a multifunctionality of 10 when b = 10 and where 100% of the active silicone oil molecules have more than 1 amino group covalently bonded to them.

The amino functional oil may be separately manufactured as a concentrate and subsequently diluted with nonfunctional polyorganosiloxane oil to provide a mixture with a distribution of amines in a large group of siloxanes. In making the concentrate a broader distribution of the amine functionality, mono-, di- and tri-amino is usually obtained. Alternatively, and preferably, in formulating the monoamino functional oil a desired level of amine concentration and final molecular weight are decided upon and the appropriate

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amounts of amine containing monomer, nonamine containing monomer, trimethylsiloxy end blocker and polymerization catalysts are added to the reaction vessel. This procedure maximizes the monoamino functionality per active molecule. In contrast to this procedure, where a concentrate is first prepared there is greater opportunity for a larger fraction being of multifunctionality since a concentrate is being prepared and there are a lot more amine groups present in the initial concentrate thereby creating the opportunity for greater amino functionality per active chain. In contrast in the batch or one pot or one shot process the amount of ingredients added is varied to provide or maximize the monoamino functionality per active molecule. Although the batch or one shot process is preferred it is possible to make the monoamino functional oil according to the present invention in a continuous run process with appropriate control over the timing of addition and the amount of ingredients added. With regard to the manufacture of the amino functional oil according to the batch or one shot process, attention is directed to the above referenced U.S. Application Serial No. 08/164,853 entitled "Fusing System With Monoamino Functional Silicone Release Agent" which is hereby specifically and totally incorporated by reference in the present application.

By the term active molecule as used herein we intend to define the silicone oil molecule having the amino functional group as part of its chemical structure. Typical substantially monoamino functional polyorganosiloxanes include among others, methyl aminopropyl methyl siloxane, ethyl aminopropyl methyl siloxane, benzyl aminopropyl methyl siloxane, dodecyl aminopropyl methyl siloxane, aminopropyl methyl siloxane. These monoamino polyorganosiloxanes typically have a viscosity of from abut 100 to about 1,000 centipoise at 20 °C. This permits easy handling of the oil particularly when delivering it to the fuser roll.

In a preferred embodiment the amino functionality is provided by aminopropyl methyl siloxy groups. As may be observed from the formula the functional amino group is at some random point in the backbone of the chain of the polyorganosiloxane which is flanked by trimethylsiloxy end groups. Also, as may be observed from the formula, the amino group may be a primary or a secondary amine wherein one of the hydrogens is substituted by R_5.

Of course it will be understood that the above described monoamino functional siloxane may be used in conjunction with nonfunctional organosiloxane oils provided that the amino functional organosiloxane chains comprise from about 0.01 to 0.30 mole percent of the total number of organosiloxy groups.

The T-type amino functional oil according to the present invention is to be distinguished or contrasted from the more traditional D-type amino oils as described in the above cross referenced copending applications and represented by the formula:

$$(CH_3)_3Si-O-\left[\begin{array}{c} R_2 \\ | \\ Si-O \\ | \\ R_1 \end{array}\right]_n-\left[\begin{array}{c} R_4 \\ | \\ Si-O \\ | \\ R_3 \\ | \\ NHR_5 \end{array}\right]_p-Si(CH_3)_3$$

where $50 \leq n \leq 200$, p is 1 to 5 and R_1, R_2 and R_3 are selected from the group consisting of alkyl and arylalkyl radicals having 1 to 18 carbon atoms, R_4 is selected from the group consisting of alkyl and arylalkyl radicals having 1 to 18 carbon atoms and a polyorganosiloxane chain having 1 to 100 diorganosiloxy repeat units, and R_5 is selected from the group consisting of hydrogen, alkyl and arylalkyl radicals having 1 to 18 carbon atoms in that after being anchored to the FKM hydrofluoroelastomer fusing surface instead of having only two chains of siloxane to provide release coverage on of the FKM hydrofluoroelastomer surface for the fused toner image there are three siloxy chains in the T-type attached to a central silicon atom which also has the functional amine group attached to it, which provide a better shielding or release coverage of the FKM hydrofluoroelastomer surface for the fused toner image, thereby providing a substantially more uniform interfacial barrier layer to the toner and a low surface energy film to release the toner from the surface. By the phrase "substantially more uniform interfacial barrier layer" we intend to define a layer which provides substantially more percentage coverage on the fusing surface than with the D-type release agents and one which typically provides at least 40 percent coverage of the fusing surface and preferably at least about 60 percent coverage of the fusing surface. This provides reduced opportunity for the toner, which also may react with the oil, to cause adhesion of the toner to the FKM fusing surface and life failure at hot offset. In addition to providing greater coverage of the FKM fusing surface the T-type amino functional oils may be used at a lower concentration than the D type amino

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functional oils. For example, under the same conditions, with the T-type oils a concentration of 0.008 mole% (moles of amino functional groups per total moles of organosiloxy functional groups) provides satisfactory release without hot offset failure while D-type oils require concentrations greater than 0.012 mole%. Furthermore, the most uniform coverage of the FKM hydrofluoroelastomer by T-type amino functional oils according to the present invention is achieved when the siloxy groups q, n and m are the same or about the same length as this provides the most maximum coverage and the most substantially uniform coverage of the FKM hydrofluoroelastomer fusing surface by the T-type amino functional oil.

The FKM hydrofluoroelastomers, according to the present invention, are those defined in ASTM designation D1418-90 and are directed to fluororubbers of the polymethylene type having substituent fluoro and perfluoroalkyl or perfluoroalkoxy groups on a polymer chain.

The fluoroelastomers useful in the practice of the present invention are those described in detail in the above referenced US-A-4,257,699 to Lentz, as well as those described in commonly assigned copending US-A-5,017,432 to Eddy et al. and 5,061,965 to Finsterwalder et al. As described therein, these fluoroelastomers, particularly from the class of copolymers and terpolymers of vinylidenefluoride, hexafluoropropylene and tetrafluoroethylene, known commercially under various designations as Viton A, Viton E60C, Viton E430, Viton 910, Viton GH and Viton GF. The Viton designation is a Trademark of E. I. DuPont deNemours, Inc. Other commercially available materials include Fluorel 2170, Fluorel 2174, Fluorel 2176, Fluorel 2177 and Fluorel LVS 76, Fluorel being a Trademark of 3M Company. Additional commercially available materials include Aflas a poly(propylene-tetrafluoroethylene), Fluorel II (LII900) a poly(propylene-tetrafluoroethylene-vinylidenefluoride) both also available from 3M Company as well as the Tecnoflons identified as FOR-60KIR, FOR-LHF, NM, FOR-THF, FOR-TFS, TH, TN505 available from Montedison Specialty Chemical Co. Typically, these fluoroelastomers are cured with a nucleophilic addition curing system, such as a bisphenol crosslinking agent with an organophosphonium salt accelerator as described in further detail in the above referenced Lentz Patent, and in U. S. Patent No. 5,017,432 to Eddy et al.

In a particularly preferred embodiment, the fluoroelastomer is one having a relatively low quantity of vinylidenefluoride, such as in Viton GF, available from E. I DuPont deNemours, Inc. The Viton GF has 35 weight percent vinylidenefluoride, 34 weight percent hexafluoropropylene and 29 weight percent tetrafluoroethylene with 2 weight percent cure site monomer. It is generally cured with a conventional aliphatic peroxide curing agent.

It is believed that the amino functional oil can react with any toner capable of reacting with amino groups and the fluoroelastomer fuser roll surface. Multifunctional amino silicone oil molecules can react simultaneously with both the unsaturation in toner and the fuser roll surface thereby adhering the toner to the fuser roll surface and forming the basis for further toner offset, shortening the functional life of the fuser roll. Accordingly, a multifunctional amino oil has the capability of acting as an adhesive between the toner and FKM hydrofluoroelastomer fuser roll surface. A mono functional amino oil molecule can react either with the toner or the fluoroelastomer roll surface but not both hence it can not act as a toner/fuser roll adhesive. Furthermore, it is believed that the amino groups attack the hydrofluoroelastomer chain and form a chemical bond between the nitrogen atom and the chain by displacing a fluorine atom from the hydrofluoroelastomer chain (Ref. Fluoropolymers, Ed. L. Wall, p. 294, Wiley-Interscience, 1972). While some of the functional oil is consumed by being carried away by paper or worn off, the continuous resupply of release agent insures that the chemical bond between the amino groups and the hydrofluoroelastomer is maintained.

This combination of hydrofluoroelastomer and monoamino functional polyorganosiloxane has some enormous advantages in that there is no metal, metal oxide or other reactive filler necessary to be present in the fusing surface to act as an anchoring site for the release agent as in the case with the mercapto polyorganosiloxane release agent. In addition to simplifying the fabrication of the fusing surface, fusing performance is enhanced in that the degradative effect of the charge control agent on the fluoroelastomer is reduced and safety considerations due to the use of heavy metals are eliminated. Furthermore, there is no offensive odor such as with the mercapto functional release fluid in that there is no sulfur smell as a result of the presence of hydrogen sulfide. Furthermore, the monoamino functional polyorganosiloxane can react with any portion of the hydrofluoroelastomer and does not require the presence of a reactive site such as the copper oxide which is typically provided for many of these materials. The monoamino functional oil may of course be used with a hydrofluoroelastomer fusing surface which does contain metal or metal oxide reactive sites. In addition, the mercapto functional release agents begin with relatively small reactive sites which have to spread, making it much more difficult for the mercapto functional fluid to get complete coverage over the entire fusing surface, since anchoring sites are necessary and the fluid has to bridge between the sites. Thus, for the same total number of amino groups there are more chains that are active and the amino groups are distributed as a relatively thin layer over the entire fusing surface.

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The following examples further define and describe the fusing system, method and release agent according to the present invention. Unless otherwise indicated all parts and percentages are by weight. Unless otherwise indicated all testing was conducted in the same manner and with the same equipment.

EXAMPLES

The described release agents were evaluated on a three inch bench web fixture, the web continuously running at 20 cm/sec. The fuser roll coating was comprised of 1.5 mm of a thermally conductive silicone rubber with a release overcoat of 0.050 mm Viton GF cured with DuPont's VC-50 curing system. The Viton GF layer contained no heavy metal oxides. The fuser roll was 50 mm in diameter and was operated at 20 cm/sec. surface speed and at a run temperature of 370° F which is 30° F above the temperature at which image fix becomes acceptable.

A polyester toner was used and the image coverage was 50%. The level of toner as the image on the paper carrier was 1.0 mg/cm^2. The polyester was made with fumaric acid and hence it was unsaturated. The toner contained the proper amount of aerosil to promote toner flow and a charge control agent to provide the necessary tribo characteristics for toner development. Failure, hot offset, occurs when part of the toner image becomes attached to the fuser roll and is then transferred to the paper on the next revolution of the fuser roll.

The following table illustrates the dramatic improvement in life to failure of the T-type amino functional oils compared to the D-type amino functional oils. Failure mode in each instance was hot offset after the stated number of prints. Examples 1,2 and 3 are comparative examples for D-type oil with n = 135 and Example 4 is for T-type oil according to the present invention with n + q + m = 135. The molecular weight and viscosity of both types of oils was the same.

Example	Oil Type	Concentration	Oil Rate	Roll Print Life
		mole % of amine functionality per total organosiloxy group	micro liters/copy	
1	D	0.020	3.0	24K
2	D	0.020	5.2	59K
3	D	0.020	6.8	66K
4	T	0.020	3.9	140K

As may readily be observed from the above, there is a dramatic improvement in fuser roll life of more than at least 100% and potentially very much greater with the T-type oil according to the present invention.

As may also readily be observed from the above examples the T-type amino functional silicone oil molecules having one and only one polyorgano amino functional group provides a dramatically long life with no hot offset after at least 140K prints which is characteristic of the life required in high volume, high speed, high quality electrostatographic machines.

Thus, according to the present invention a substantially improved fusing system method and T-type amino functional release agent have been provided and in particular a system wherein the release performance is dramatically improved over the D-type amino release agents. Furthermore, by limiting the number of functional amino groups per polyorganosiloxane chain to one and only one in at least 85% and preferably about 93% of the chains, the opportunity for the release agent to react with both the hydrofluoroelastomer fusing surface and the toner in such a manner as to adhere the two together thereby preventing the desired quality of release leading to failure from offset has been prevented. Most importantly, with this high degree of amino monofunctionality in the silicone release agent, the fusing system according to the present invention has application for extended use in high speed, high volume, and high quality printing machines. In addition, since no metal or metal oxide or metal compound filler is required in the fusing surface to act as a reactive site to anchor the mercapto functional fluid reductions in fabrication costs are achieved as well as improved performance as noted above together with reduced reactivity with charge control agents and no odor.

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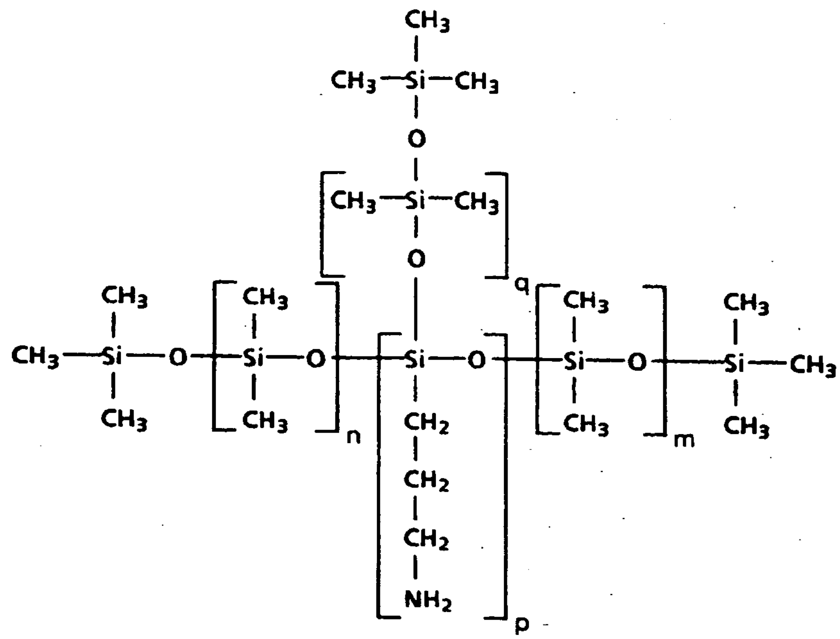
Claims

1. A fluid release agent for application to a fuser member having a thermally stable FKM hydrofluoroelastomer surface for fusing thermoplastic resin toners to a substrate in an electrostatographic printing apparatus comprising a T-type amino functional oil having the formula:



where $50 \leq n \leq 200$, p is 1 to 5, $50 \leq m \leq 200$ and q is 1 to 200 wherein at least 85% and preferably about 93% of the polyorgano aminosiloxane functional chains have p equal to 1 said oil having predominantly monoamino functionality per active molecule to interact with said hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to said toner and a low surface energy film to release said toner from said surface.

2. A release agent as claimed in claim 1, wherein about 93% of the polyorgano amino functional siloxane chains have p equal to 1.

3. A release agent as claimed in claim 1, wherein said amino functionality is provided by aminopropyl methyl siloxy groups.

4. A release agent as claimed in any of claims 1 to 3, wherein said amino functional oil remains functionally fluid at temperatures of from about 30° F to about 450° F and/or has a viscosity of from about 100 to about 1000 centipoise at 20° C.

5. A release agent as claimed in any one of claims 1 to 4, wherein said monoamino functional oil is prepared in a batch process and subsequently diluted with nonfunctional polyorganosiloxane oil.

6. A release agent as claimed in any one of claims 1 to 5, wherein the n, q and m siloxy groups are about the same length.

7. A method of fusing thermoplastic resin toner images (14) to a substrate (12) comprising providing a heated thermally stable FKM hydrofluoroelastomer fusing surface (2) at elevated temperature, forming a film of a fluid release agent on said elastomer surface comprising an amino functional oil having the formula:

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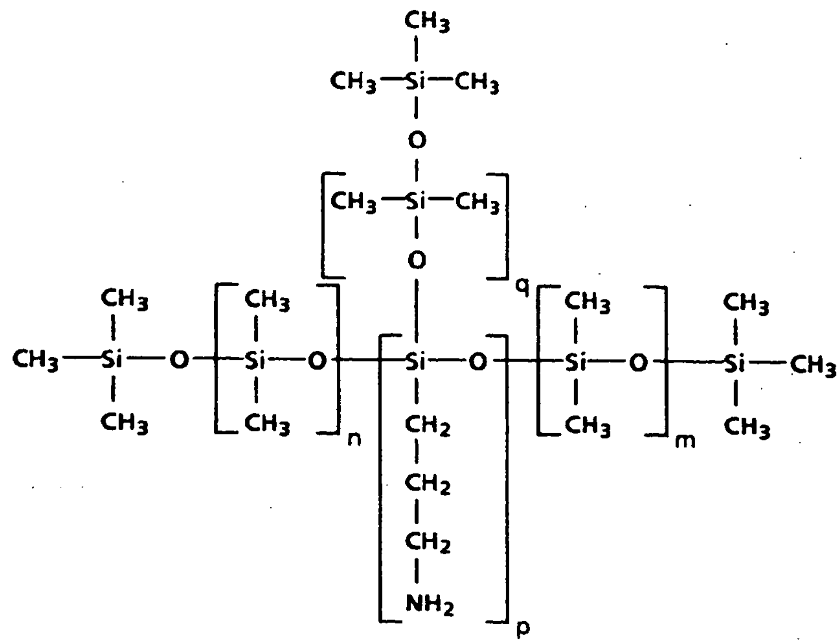

where $50 \leq n \leq 200$, p is 1 to 5, $50 \leq m \leq 200$ and q is 1 to 200 wherein at least 85% of the polyorgano aminosiloxane functional chains have p equal to 1, said oil having predominantly monoamino functionality per active molecule to interact with said hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to said toner and a low surface energy film to release said toner from said surface; contacting the toner image on the substrate with the filmed heated elastomer surface to fuse said toner image to said substrate and permitting said toner to cool.

8. A method as claimed in claim 7, wherein said amino functional oil is present with nonfunctional organosiloxane oil in an amount of from about 0.01 to about 0.30 mole percent of the total number of organosiloxy groups.

9. A method as claimed in claim 7 or claim 8, wherein said oil forms a substantially uniform interfacial barrier layer with said hydrofluoroelastomer surface in the absence of a heavy metal, heavy metal oxide or other heavy metal compound anchoring site for said oil.

10. A method as claimed in any one of claims 7 to 9, wherein said toner is susceptible to reaction with amines.

11. A heated pressure fusing system for fusing thermoplastic toner in an electrostatographic printing apparatus in which a heated fuser member (1) and a backup pressure member (8) define a fusing arc (10) to fuse toner images (14) to a substrate (12), said fuser member comprising a thermally stable FKM hydrofluoroelastomer fusing surface (2) and means (17,19) to deliver a release agent to said surface, said release agent comprising a fluid amino functional oil having the formula:

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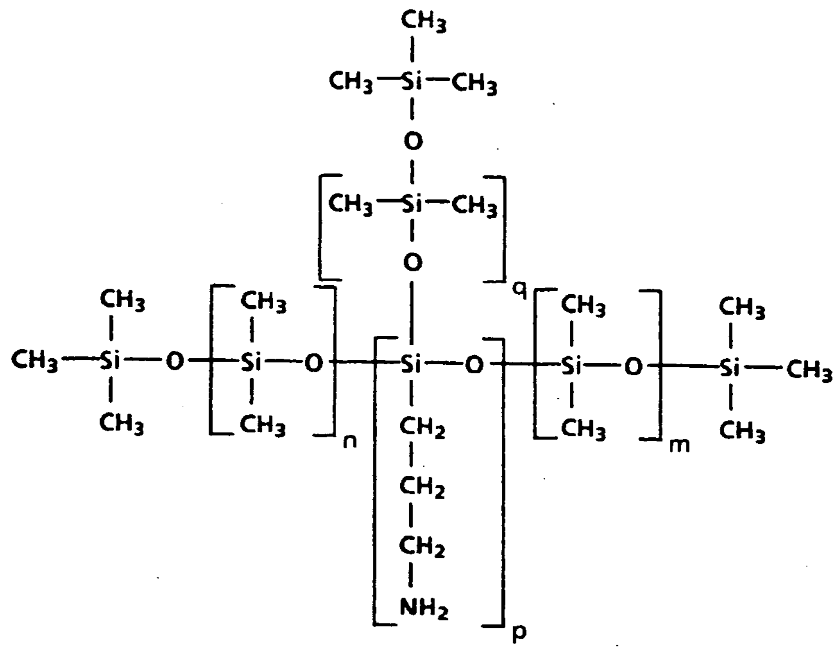

where $50 \leq n \leq 200$, p is 1 to 5, $50 \leq m \leq 200$ and q is 1 to 200 wherein at least 85% and and preferably about 93% of the polyorgano aminosiloxane functional chains have p equal to 1 and said oil having predominantly monoamino functionality per active molecule to interact with said hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to said toner and a low surface energy film to release said toner from said surface.

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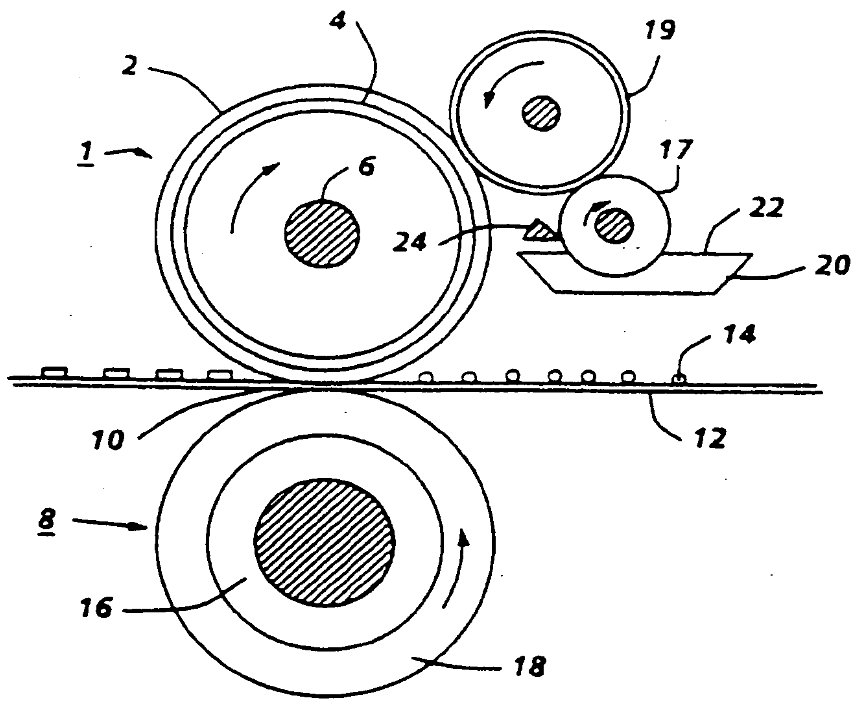

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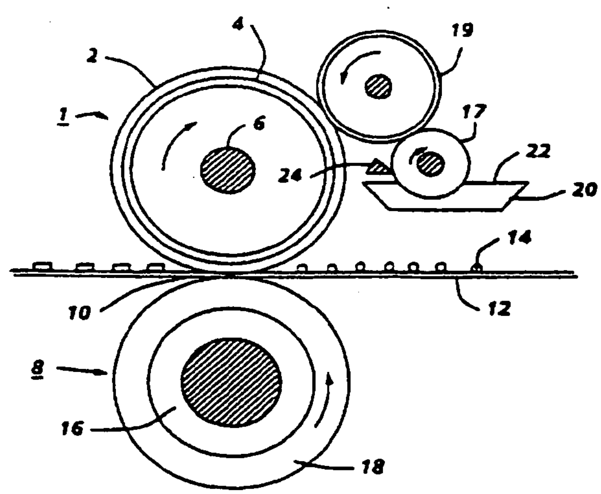
(71) Applicant: **XEROX CORPORATION**
Rochester New York 14644 (US)

(72) Inventors:
- **Henry, Arnold W.**
  Pittsford, NY 14534 (US)
- **Seanor, Donald A.**
  Pittsford, NY 14534 (US)
- **Kaplan, Samuel**
  NY 14568-9787 (US)
- **Pan, David H.**
  NY 14625 (US)
- **Heeks, George J.**
  NY 14617 (US)
- **Eddy, Clifford O.**
  NY 14581-1321 (US)
- **Chow, Che C.**
  NY 14526 (US)
- **Badesha, Santokh S.**
  NY 14534 (US)
- **Kromm, Alvin D. Jr.**
  NY 14580 (US)

(74) Representative: **Johnson, Reginald George et al**
Rank Xerox Ltd
Patent Department
Parkway
Marlow Buckinghamshire SL7 1YL (GB)

(54) **Fusing system and fluid release agent**

(57) A fusing system, method of fusing with a fuser member (1) having a thermally stable FKM hydrofluoroelastomer surface (2) for fusing thermoplastic resin toners to a substrate (12) in an electrostatographic printing apparatus has a polyorgano T-type amino functional oil release agent, the oil having predominantly monoamino functionality per active molecule to interact with the hydrofluoroelastomer surface to provide a substantially uniform interfacial barrier layer to the toner and a low surface energy film to release the toner from the surface.



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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 322 099 (CANON KK) 28 June 1989 * claim 10 *	1,7,11	G03G15/20
D,A	US-A-5 157 445 (SHOJI YOSHIO ET AL) 20 October 1992 * claims *	1,7,11	
D,A	US-A-4 272 179 (SEANOR DONALD A) 9 June 1981 * claims 1,14-18 *	1,7,11	
D,A	US-A-4 185 140 (HOFFEND THOMAS R ET AL) 22 January 1980 * column 6, line 11 - line 52 *	1,7,11	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	20 December 1995	Hoppe, H

CATEGORY OF CITED DOCUMENTS

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